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Editorial

Anaortic total arterial OPCAB – Panacea to all ills?☆

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An interesting case report on anaortic total arterial off-pump coronary artery bypass surgery (OPCAB) published later in the journal, only go to attest the fact that there is no limit to technical ingenuity and permutation and combinations that can be drawn to do bypass surgery. After all heart needs blood, no matter how it comes. Compliments to the authors because the 'whole' that they have achieved is definitely more than the sum of the parts viz Anaortic, Total Arterial and OPCAB. Lets look at the parts independently with a view to answering the conundrum – Can anaortic total arterial OPCAB be considered the best form of surgical revascularisation, as advocated by the authors?

1. Anaortic Grafting

Cerebrovascular accidents (CVA) continue to be a thorn in the flesh of a cardiac surgeon.[1–3] Saha et al (later in the journal) have extolled the virtues of anaortic total arterial OPCAB. Let me play a devil's advocate to put matters in perspective. Of the protean ways that one can develop CVA following bypass surgery, showering of the atheromatous debris from the aorta is the commonest, with aortic clamping the modus operandi, irrespective of it being a 'cross clamp' or a partial side bitting clamp.[4] Clampless anaortic bypass has been advanced to address this issue[5] and results far superior to conventional CABG (stroke 1.3 vs 3.4%; p-0.32) and comparable to PCI arm of the SYNTAX Trial (stroke 1.3 vs 2.0%; p-0.347) were achieved in the aortic no-touch OPCAB subgroup by Arrigoni et al.[6] However, other mechanisms like water-shed ischemic infarcts, in situ thrombus, intracranial bleeds, embolization from cardiac and other sites, do continue to operate and exhibit as strokes, albeit much less commonly. Not withstanding all this anaortic total arterial bypass does reduce the incidence of stroke.[7] An alternate to anaortic revascularisation is the no-touch proximal anastomosis to aorta using HEART STRING device, which too minimizes athero-embolism based neurological complications.[8]

Anaortic grafting essentially involves Pedicled Internal Mammary Artery (IMA) based single or double inflow with all grafts hitched as composite 'T' or 'Y' grafts. The initial fears of the flow being insufficient, especially in presence of Left Ventricular (LV) hypertrophy, has largely been dispelled with demonstration that the IMA size increases with time and being a dynamic graft, it adjusts the flow to the demands of the myocardium.[9,10] Further there is both randomized and observational evidence that composite grafting does not compromise graft patency or survival.[11]

However, no matter what technique one takes, to err is human and err we all, and that too at most inopportune moments. Technical errors may occur in best of hands and upto 3–5% grafts are blocked on the operating table.[12] Infact Mannacio et al, in a series of 148 cases undergoing Coronary Artery Bypass Surgery with a composite of LIMA-Radial 'Y' Graft, found scintigraphic evidence of stress induced ischemia in 24 patients at 3 years, even though clinical adverse events were rare.[13]

Spasm is the Achilles heal of all arterial grafts and IMA, histo-anatomically a somatic artery, is capable of undergoing severe spasm leading to transmural myocardial infarction and even death.[14] Endothelin and Thromboxane A2 are potent vasoconstrictors of the IMA and both have been found to be elevated during cardiopulmonary bypass, and have been incriminated in peri-operative IMA spasm.[15] Other realistic modes of graft failure are harvest related conduit trauma, pre-existing vascular pathology and competitive flow mediated string sign.

In this milieu therefore, when anaortic total arterial bypass, places 'all eggs in limited baskets', it is very important that some form of intra operative assessment of grafts,

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preferably using both morphological and functional imaging techniques,[16] must be resorted to in order to pick and remedy inadvertent errors, and thereby avoid potentially disastrous consequences. Bonatti et al showed that three out of 23 patients needed graft revision based on intra operative angiography.[17] This is likely to be much higher in a technically demanding subset of patients, such as those with diffuse disease, where not only the coronary arteries are small in size, but also the tissue planes get obliterated with severe inflammatory reaction and fibrosis.

2. Off pump vs pump surgery

After initial rapid proliferation of OPCAB worldwide, the tempo dampened somewhat because of consistent reports of incomplete revascularisation[18,19] and the first ever RCT comparing the two procedures, the Randomized On/Off Bypass study (ROOBY), showing that at one year follow up OPCAB patients had worse composite outcomes of death, myocardial infarction (MI), graft patency and repeat revascularisation.[20] Patency of grafts placed Off-Pump was sub-optimum even in the one year follow up angiography study of the ROOBY Cohort as also the DOORS Study.[21] ROOBY study was challenged because of surgeons' inexperience.[22] However, it found support in a Cochrane review meta analysis from Copenhagen,[23] which showed a 30% higher risk of all cause mortality with OPCAB as compared to On-Pump CABG, along with a slightly lower number of distal anastomoses. To the contrary, meta analysis by Afilalo et al[24] and BHACAS I & II Trials by Angelini et al[25] lent support to Off-Pump ideologues. Best Bypass Surgery[26] and CORONARY[27] trials were equivocal with no difference between primary composite end points of death, MI, stroke and renal failure but secondary outcomes, especially use of blood products, bleeding and acute kidney injury were marginally less in OPCAB. Even though the German Off-Pump Coronary Artery Bypass in Elderly (GOPCABE) Study[28] showed no benefit of off-pump over on-pump surgery in matters of neurological events, there is compelling evidence to the contrary[7,8,29,30] with a 35% reduction in CVA for OPCAB Versus On-Pump Surgery in STS Adult Cardiac Surgery database (OR 0.65; p-0.001).[31] All this confusion seem not to dampen the indomitable spirit of the Indian cardiac surgeons, who persist with OPCAB with no clear objective evidence supporting this enthusiasm. What ever little evidence we have is anecdotal case reports, with no level of evidence 'A' literature emanating from this country to support Off-Pump surgery. As against, western literature keeps churning high quality data and delivering knock out blows, the final one being from Sepehripour et al,[32] who looking at Off-Pump vs On-Pump surgery in a total of 25 articles published in world literature, according to a structured protocol, systematically demolished OPCAB.

3. Total arterial revascularisation (TAR)

Despite in-controvertible evidence favoring use of bilateral IMAs[33] (Ref. Table 1) – indeed 'an inconvenient truth',[34] their use is appallingly low (4.1–12.6%),[11] which in Bruce Lytle's words, 'borders on the unethical'. Infact Bannon[35] makes a plea for eschewing the adhoc or default use of saphenous vein. However, all these pleadings & implorings make no headway with the materialistic mind set of time-poor cardiac surgeons, who infact side step the real issues of labor intensiveness of the procedure and time constraint, in the garb of increased sternal morbidity attendant to bilateral IMAs, as also a potential for steal in distal LIMA-LAD.[36] By the same token, even though LIMA to LAD remains a gold standard, use of two IMAs do not translate into twice the goodness of single IMA.

Taggart et al,[37] in the ART Trial, have clearly shown that the early outcomes upto one year are exactly the same in terms of mortality, CVA, MI and repeat revascularisation. Cons of bilateral IMAs include increased length of operation, increased ventilation time, increased sternal wound reconstruction (1.9% vs 0.6%) and increased wound complications in diabetic patients.[37] Increase in sternal infection in bilateral IMAs was shown even by Raza et al,[38] but it did not have any effect on survival. To the contrary bilateral IMAs reduced the mortality by 21%. The risk factors for deep sternal wound infection were shown to be female sex (80% increased risk), body mass index (7% increase per/kg/meter^2), diabetes mellitus (73% increase), previous MI (58% increase) and presence of peripheral vascular disease (73% increase). Skeletonization of IMA may preserve sternal blood supply and decrease the risk of sternal infection especially in diabetic patients.[39] However, Agrifoglio et al,[40] Momim et al[41] and Chung et al[42] did not encounter increased sternal wound infection in their series of bilateral IMAs, even in diabetics.

Salutary effects of bilateral IMA on long term survival[43,44] and their safety and efficacy even in diabetics were quite conclusively demonstrated by Lev-Ran et al[45] with freedom from cardiac mortality at 7 years of 92% vs 68% with LIMA alone ($p < 0.0001$). Conservative arguments against use of TAR in elderly patients, those with LV or renal dysfunction and in emergency settings have been systematically eroded by accumulating evidence,[46] thus mandating that surgical community better yield, however, discretion is the better part of valor and despite there being no absolute contraindications, prudence demands that Bilateral IMAs be avoided in patients with insulin dependent diabetes mellitus, significant obesity and chronic obstructive airway disease[34] and possibly a friable and osteoporotic sternum. Miscellaneous issues like long elapsed time of operation, hypothermia, specially in elderly, obese and diabetic patients and the potential for rare, but devastating, complications like bilateral phrenic nerve palsy,[11] should also be considered in decision making. So even though bilateral IMAs definitely improve survival, reduce MACE and repeat revascularisation rates on long term basis,[43,46,47] marginally increased short term risks, though mitigated but not eliminated in contemporary surgical practice, should always be factored in.

The LIMA – RA anastomosis, even though practiced routinely,[48] seems jarring to an intuitive mind as the vessel wall quality of the two is totally different, one being elastic and the other a muscular artery, and therefore must play a second fiddle to LIMA-RIMA 'Y' grafting, which match perfectly and blend sublimely.

Lastly let us not forget that all we are doing is epicardial revascularisation, and touch we cannot the micro circulation. Even sub-optimum techniques like 'soft-spot-any-where'

Table 1 – Summary of large cohort studies comparing use of bilateral and single internal mammary artery grafts for coronary artery bypass surgery (Vallely et al[11]).

Author	Year	N		Description	Age		Results	
		BIMA	SIMA		BIMA	SIMA	BIMA	SIMA
Taggart 2001	1989–1999 (publication dates)	4693	11,269	Meta-analysis of 7 (non-randomized) studies; each study at least 4 y follow-up			BIMA: HR death 0.81 (95% CI, 0.70–0.94)	
Berreklouw 2001	1985–1990	249	233	Retrospective, consecutive patients; excluded patients with reoperations, free IMAs, gastroepiploic artery grafts, combined procedures; mean follow-up 10 y	53.7 ± 8	56.0 ± 8.1	13 y ischemic event-free survival 47.5% (±8.4%) HR 1.6 (95% CI, 1.3–2.3)	13 y ischemic event-free survival 35.4% (±5.1%)
Lytle 2004	1971–1989	1152	1152	Retrospective, propensity score matched; primary isolated CABG, non-emergent patients; excluded patients with other arterial grafts; mean follow-up 16.5 y	57.5 ± 8.1	57.8 ± 8.3	Survival BIMA: 7 y-89%; 10y-81%; 15y-67%; 20y-50%; all BIMA us. SIMA $P < 0.0001$	Survival SIMA: 7 y-87%; 10y-78%; 15y-58%; 20y-37%
Ruttman 2011	2001–2010	277	724	Retrospective, consecutive patients; BIMA vs LIMA/RA; primary, non-emergent CABG; excluded MI within 1 week; follow-up57.7 months	56.6 ± 9.6	59.9 ± 7.9	MACCE 1.4%; RR 1.4%; MI 0.4%. Survival HR 0.23 (95% CI, 0.07 –0.81)	MACCE 7.6%; RR 5.2%; MI3.6%
Taggart 2010	2004–2007	1548	1554	Multicenter RCT; included those considered for CABG with multi-vessel disease; excluded patients with evolving MI, single grafts, re-operations; follow-up 1 y	63.7 ± 8.7	63.5 ± 9.1	Mortality 1.2%. Sternal wound breakdown 1.9%	Mortality 1.2%. Sternal wound breakdown0.6%
Grau 2012	1994–2010	928	928	Retrospective, propensity score matched; included all patients undergoing isolated CABG; excluded single grafts, use of radial artery	60.9 ± 9	62.1 ± 9	Survival: 1 y-99%; 3 y-96%; 10 y-89%; 15y-79%	Survival: 1 y-99%; 3y-91%; 10y-79%; 15y-61%

BIMA, bilateral internal mammary artery; CABG, coronary artery bypass grafting; CI, confidence interval; HR, hazard ratio; IMA, internal mammary artery; MACCE, major adverse cardiac and cerebrovascular events; MI, myocardial infarction; RA, radial artery; RCT, randomized controlled trial; RR, repeat revascularisaion; SIMA, single internal mammary artery.

grafting, distal grafting, endarterectomy, coronary venous bypass may have to be resorted to in more than an occasional case, besides the standard techniques of sequential grafting. Alternative modalities like cell & gene based therapies, transmyocardial laser revascularisation and heart transplantation too may have a role in an anecdotal case. Therefore in patients with diffuse disease, the extent of relief of myocardial ischemia is at best subjudice. Even in a standard bypass surgery, one third of patients do throw up a positive stress test (No functional testing has been reported post operatively by Saha et al). Absence of angina (specially in a diabetic patient) and patency of grafts are not equivalent to lack of ischemia. Probably it is only a reduction of the quantum of the ischemia. No wonder then that Mannacio et al[49] found that multiple composite grafts, albeit adequate at rest, were unable to meet flow requirements during maximal hyperemia. They issued a caveat, "In daily practice, their use must be not a choice but rather a necessity in those patients without alternative options" – Indeed a provocative statement, not endorsed by yours truly, but nevertheless a view point.

Though the index case had excellent results, yet it is a serious operation (lasting 12 h!) with potential for major complications. Further such operations are not meant for the bourgeois class among us and even for the experienced, they are a reckoning and hence, the indications for surgery must be true. Patient must have 'unacceptable' ischemic symptoms despite guideline directed optimum medical therapy. (Saha et al have not mentioned the indication for surgery).

I shall end with a quote from Prof. James Tatoulis[46] from Melbourne, 'There are many unresolved questions. Should coronary arteries of <1.5 mm internal diameter, those supplying infarcted areas, those with distal disease be grafted? Will it make any difference? If grafted, what with? Are there any benefits to place more than one graft (particularly arterial grafts) in to each coronary territory? Is there still a role for extensive coronary endarterectomy? Despite 55 years of coronary surgery practice, these questions remain unresolved'.

So, whats the best form of myocardial revascularisation? – Probably none is second to the one provided by Nature. Be honest and true to your conscience before you prescribe one!

Conflicts of interest

The author has none to declare.

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